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ABSTRACT

Computer use in the classroom is minimal for both special education students and other students. Reasons for non-use are that access to computers is limited, the quality of the instructional software is poor, and teachers find it difficult to integrate computer use with more traditional teaching methods. Interactive videodisc technology, while similar in many respects to computers, has the advantage of enhanced graphic capabilities in the form of slides, archival film, videotape segments, and computer graphics, as well as a narrative mode of presentation comparable to that of television. In a controlled experimental study of the Mastering Fractions videodisc program, significant positive effects on student achievement were demonstrated when the system was used to teach basic fractions concepts to remedial and special education secondary students. Seven teachers at 7 school sites in a large urban district taught 57 students for 6 weeks using the Mastering Fractions videodisc program. Results of the study showed: an increase in both teacher and student enthusiasm, greater interaction between teachers and students, superior student performance on a criterion-referenced test, and successful retention of the material after the original instruction. It is concluded that interactive video, while not a hidden remedy to the flagging technological revolution in the schools, may be a partial solution to the problem of effective teaching of difficult subjects. Six appended tables present supporting data, including both teacher and student responses to interviewers. (24 references) (DB)

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# Innovative Technology for Secondary Learning Disabled Students: A Multi-Faceted Study of Implementation

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Over the last decade, public schools have spent approximately two billion dollars for microcomputers. Acquisitions in special education alone grew more than 330 percent from 1983 to 1985 (Blaschke, 1985). While 96 percent of American schools have microcomputers, the typical school has a ratio of only one computer per 30 students. Furthermore, most schools house their 10 to 20 computers in a single computer lab, thus limiting computer use to an average of about 15 minutes per day per student. This growth has spawned an array of frustrations, some logistical, some instructional (Buckeley, 1988; Rothman, 1988; West, 1988).

Recent evaluations of technology use in education concluded that computers are failing as educational aids (Buckeley, 1988; Snider, 1986). Earlier in this decade, visionaries (Bork, 1981; Papert, 1980) claimed that computers would revolutionize learning. More recently, critics of educational technology (Cuban, 1986) point out that the early sanguine predictions are similar to those that accompanied previous technological innovations such as instructional television. Once initial enthusiasm palled, the educational community has utilized these technologies at an extremely modest level, and their impact on improving instruction has been minimal.

In the midst of history possibly repeating itself, some microcomputer proponents are trying to sort out what is currently happening to their "revolution" in the schools. Reasons expressed for the modest acceptance of microcomputers in the schools vary. Hofmeister (1984), in particular, has stressed the poor quality of most instructional software; a view which is now more widely shared in schools today (Buckeley, 1988). Semmel and Lieber (1986) believe the early claims about the superiority of computer assisted instruction as an alternative to traditional instruction were exaggerated.

Perhaps the most perceptive -- and inditing -- analyses come from Cuban (1986), Cohen (1987), and Wolcott (1981). They argue that computers are but another in a set of educational innovations which have largely ignored the culture of schools. Cuban (1986) stresses that computers have been forced on schools in a "top down" fashion. As computer have commonly been deployed in classrooms and labs, they don't mesh well with the various demands and routines that characterize a teacher's day. This lack of sensitivity to the realities and routines of classroom learning has resulted in a revolution that has been, at least for the moment, temporarily derailed. These views seem to apply equally well to special education as well as regular education settings.

## Problems and Issues in Technology Use in Secondary Special Education

One of the most recent surveys of microcomputer use at the secondary level indicates that special education students spend as much time on computers as average ability students (Becker & Sterling, 1987). However, they engage in very different activities on the computer than their peers. On the average, secondary students use drill and practice computer programs only 13 percent of the time. In contrast, secondary special education students spend most of their time on drill and practice, mainly in the areas of math and language arts programs (Becker & Sterling, 1987; Okolo, Rieth, Polsgrove, Bahr, & Yerkes, 1985). Where computers were not used for drill and practice, the main intent of computer use with special education students was to improve motivation, self-confidence, and self-discipline. On the other hand, when working with other secondary students, teachers' main goals were programming, computer literacy, and word processing (Becker, 1987).

Several key points need to be emphasized about use of technology in high schools, and with special education students in high school. The first point is seemingly obvious; technology use in all schools fundamentally involves microcomputers. Rarely do educators utilize alternate technologies such as videodisc instruction or more elaborate uses such as telecommunications or information retrieval from commercial databases. Second, access to these computers is typically very limited, possibly undercutting their value as tools for instructional delivery. This is true for both special education students and other students. Third, mildly handicapped students are unique among secondary students as they predominantly use microcomputers for drill and practice. However, anything beyond the drill and practice level of instruction, be it through microcomputers or other forms of computer technology, is rare for these kinds of students.

One of the few studies of microcomputer use in secondary special education (Rieth, Polsgrove, Bahr, Okolo, Eckert, & McCarthy, 1985) reveals that even though secondary special education teachers extensively supervise their students during computer use, very limited, substantive academic interaction occurs. While students tend to be engaged at high rates, it is far from clear that students are successful at their work on the computer or that they understand the content of the computer assisted instruction. Furthermore, there is little evidence that teachers are able to successfully integrate CAI with their traditional curriculum. These factors, combined with the typically high ratio of students to computers (about 30:1)

and the over-reliance on drill and practice programs make computer based instruction a poor fit with traditional secondary level instruction.

## Videodisc Instruction

An emerging alternative to conventional CAI is videodisc technology. It offers vastly superior presentational format than microcomputers. One distinct feature that differentiates videodiscs from microcomputers are the enhanced graphic capabilities. Videodiscs can store up to 30 minutes of continuous motion pictures per side or 54,000 photographic quality frames. The stored images may appear as slides, archival film, videotape segments, and/or state of the art computer graphics. A second appeal is narration, allowing students the opportunity to watch presentations rather than, for example, read from text, and examine static diagrams or charts. All of this goes well beyond the capabilities of today's microcomputers.

A further attraction is that teachers can operate a videodisc in the same fashion as a video cassette recorder, thus making the technology relatively easy to use. This last point is not trivial, as teachers with limited technical expertise are understandably bewildered with they encounter "DOS error" or scrambled letters on the computer monitor screen.

Finally, videodisc technology can facilitate group instruction. A videodisc can be operated from a distance as the teacher walks around the classroom. In doing so, the ratio of one videodisc player and its program to a classroom is satisfactory, hence solving one of the main logistical problems associated with microcomputers, which typically demands a one-to-one interaction. With the videodisc and television monitor positioned in the front of the room, the teacher is able to control the program from a distance. This allows her to circulate among the students, monitoring individual work and giving substantive feedback.

Some educational developers have been drawn to the videodisc medium because of its potential for embedding research-based effective teaching techniques into the medium. Software such as Mastering Fractions (Systems Impact, 1986), the subject of the current evaluation study, was designed following empirically-derived principles of effective instruction (Brophy & Good, 1986; Leinhardt & Smith, 1985). These include breaking each problem solving process into small steps, extensive models of problem solving strategies, use of a wide range of examples, review of relevant preskills, cumulative review, discrimination practice, and frequent assessment of student understanding of new material presented. The videodisc

program differs from more traditional approaches by teaching fractions concepts and operations in more depth, and by providing more practice.

The videodisc curriculum used in this study was based on many components of the Good, Grouws and Ebmeir (1983) model of effective mathematics instruction. One of the cornerstones of this model is the use of guided practice to frequently assess student understanding of each small instructional unit presented. There are Checks for Student Progress (CSPs), incorporated into each lesson of the videodisc curriculum, enabling teachers to determine when brief review/remediation activities is necessary. In this respect, the program was conceptually quite different from other, more typical videodisc programs, which tend to contain a lot of archival images and film clips and function as highly flexible instructional supplements (e.g., Windows on Science, Optical Data, 1988).

The use of videodisc technology for group instruction requires significant role shifts for teachers. The videodisc becomes the source of initial explanations, graphic demonstrations, and guided practice problems. This frees the teacher from the task of curriculum presentation and allows him or her to concentrate on monitoring the group and on individual assistance. In using the videodisc in this manner, a substantial portion of traditional instruction -- the portion typically devoted to curriculum presentation through problems on the chalkboard or through a lecture -- is formatted into the medium.

For example, following a three minute presentation of the concept of reducing fractions that involves computer graphics and narration, the videodisc program presents a set of two to four guided practice problems. Each set is a still frame and the teacher advances to the next frame once all the students are ready. Students copy the problems from the screen onto paper at their desk, work the problems, and the teacher then presents the next frame showing the same problems and their answers. The videodisc then shows another set of problems or presents a "decision menu" for the teacher, directing her to different sections of the videodisc depending upon student performance over the set of guided practice problems. This interactive format is very different from previous educational technologies cited by Cuban (1986), especially educational television.

A recent controlled experimental study by Kelly, Carnine, Gersten and Grossen (1986) of the Mastering Fractions videodisc program demonstrated significant positive effects on student achievement when the system was used to teach basic fractions concepts to remedial and special education secondary students. Results of the study showed superior performance of students taught with the

videodisc on a criterion-referenced post test. Effects were maintained on a measure given several weeks later. Rates of academic engagement were significantly higher for the videodisc students. However, this study utilized highly trained experimental teachers, who were carefully monitored by the researchers. When Mastering Fractions has been used under less controlled conditions, noticeable variation in the way the program has been implemented has been observed (Hasselbring, Sherwood & Bransford, 1986). It was a growing concern for the use of this technology in more typical, day-to-day settings that led us to the following study.

Research on educational innovation and school improvement (Fullan, 1982) suggests that in order to analyze a change effort, such as the use of new educational technologies, one must first describe and analyze the context. This involves examining the instructional materials used and the staff development provided (Loucks & Zacchei, 1983). This type of research entails not only observations of how teachers implement the innovation, but also a probing of teachers' attitudes and beliefs toward it. A comprehensive multi-faceted evaluation should also examine the impact of the innovation on student learning. Fullan (1982) correctly notes that students, the ultimate recipients of new instructional programs, are typically neglected as sources for reactions to innovation.

Therefore, a range of instruments were developed to capture the implementation. The level of implementation of the program by the teacher was assessed, along with transfer of training following the videodisc experience. Teachers' reactions and perceptions were probed through semi-structured interviews. Student achievement was documented through a curriculum referenced test covering the major topics in fractions.

Finally, a special effort was made to interview the 57 students who participated in the study. As the program required far greater active student involvement than traditional instruction, it was important to document the students' reactions in a variety of ways. Finally the evaluation will assess whether use of the innovation has any transfer effects (i.e., any impact on teachers' conventional instruction).

This article reports on a study of technology use in special education classes at the secondary level -- interactive videodisc -- using a multi-faceted approach. Our concern was less an evaluation of how well students learned with the new technology than an evaluation of how teachers used it; what factors led to successful

implementation; and to what extent the technology fit into their current classroom situation.

## Method

### Subjects and Setting

Prior to the 1987-1988 school year, secondary special education teachers in a large district were contacted in the late summer regarding a new fractions program. Only a small subsample of the district's secondary special education teachers were eligible to participate in this study, either because they were not scheduled to teach fractions in the fall or because they were unavailable for the initial inservice. Of the eight teachers contacted, only one declined to use the curriculum. All seven participating teachers taught mathematics in secondary resource room programs for mildly handicapped students. The average teaching experience was 11.7 years, with an average of 7.2 years in special education and 9 years of teaching mathematics.

The study took place is one of the ten largest districts in the United States. As in most large urban districts, the student population is diverse, approximately 45 percent of the students were minority. The seven school sites involved in this study ranged from upper middle class neighborhoods to inner-city, low income settings.

For each teacher, only one section of Basic Math participated in the study. Teachers were free, however, to use the curriculum with other sections of this course, and four of the teachers did so. These classes typically consisted of 6 to 15 students. All students were eligible for the study except those who performed poorly on a test of basic computation skills (e.g., simple addition and subtraction). Three students were excluded for this reason. In the end, 57 students participated over the six week intervention period. All were classified as learning disabled; all were receiving special mathematics instruction as specified by their individual education programs (IEPs).

### Intervention Procedures

Teacher training. Participating teachers attended two one-hour training sessions prior to implementation in which they were provided with an overview of videodisc technology, an introduction to the fractions curriculum, a demonstration of how to operate the videodisc equipment, and guidelines for implementation of the program in the classroom.

The initial training allowed participants to learn some of the theory behind the program (Showers, Joyce, & Bennett, 1987), provided a demonstration of what a typical lesson should look like, and provided limited practice with the new technology. The quantity and nature of the training was designed to parallel the amount of generally provided by publishers of standard curricula.

In the second session, approximately 30 minutes was allocated for 'hands-on' practice with the videodisc equipment. Teachers were encouraged to spend time familiarizing themselves with the equipment and with content of the lessons, before presenting the first lesson to their students.

Four specific aspects of implementation were stressed during the training: a) spending at least 45 minutes of the class period for the lesson presentation and corresponding workbook exercises; b) use of guided practice to assess student comprehension at the 3-4 designated points during each lesson (called "Checks for Student Progress"); c) monitoring students' work throughout all segments of the lesson; and d) teaching to mastery. Student mastery of the material, rather than "automatic" progress of one lesson per day, was stressed in the initial training. Teachers were taught how to use the "remediation options" in the program.

Program implementation. Beginning in early October, the seven participating teachers used the Mastering Fractions program with their students for a period of six weeks. The number of lessons teachers covered in this time was contingent upon the day-to-day progress of their students. At the end of the implementation, most teachers had completed approximately 24 of the 35 lessons of the University of Oregon program.

Throughout the study, an individual knowledgeable in curriculum implementation and the technology was available to assist teachers with questions about the program, particularly the logistical ones (e.g., how to operate the remote control device, where to position the monitor for optimal viewing). Teachers asked for assistance or feedback on a voluntary basis. The facilitator was often able to use "how am I doing?" situations for constructive feedback. However, this component varied as a function of teacher requests for such feedback or assistance. Some availed themselves of her assistance four or five times in the six weeks of implementation, others only once to deal with specific technical problems and/or mechanical problems with the videodisc technology.

Measures

Measures of teachers' implementation of the innovation. Each teacher was observed for two consecutive lessons during the fourth or fifth week of implementation. The observers were two researchers, one of whom was an expert in the program and the other an experienced educational consultant who was highly familiar with the content and teaching style of the videodisc curriculum. Implementation was assessed with the Videodisc Implementation Observational Scale. Table 1 (below) presents the specific items on the scale. Observers completed this form after a full 45 minute observation. The first 4 items were yes/no items; the latter 5 items were completed on a 1 to 3 scale, (1 was never, 2 sometimes, 3 always). Inter-observer reliability for the observational system was .87.

The observational system also included direct counts of several variables. The observers recorded: a) the number of explanations teachers provided that were consistent with the language and terminology of the videodisc curriculum; b) the number of explanations that used contradictory language, or confusing language; and c) all instances of teacher praise and criticism. Every five minutes, they recorded the percent of students academically engaged, and those "off task." Finally, the daily seatwork was collected and scored by the observer to obtain a measure of student success rate.

Teachers reactions and perceptions to the intervention: Semi-structured interviews. At the end of the study, a semi-structured 40 to 50 minute interview was administered to all teachers by the researchers. The 17-item interview contained both questions with a yes/no answers such as, "Do you find the videodisc itself hard to use?" and "Does it end up slowing down progress?" as well as more open-ended questions such as "What are the best features of the program?" , "What are its weakest features?", and "What are the major ways that it is different from how you taught fractions before?" Finally, teachers were asked to give an overall assessment of the experience of using the videodisc program to teach fractions to these students on a 1 to 5 scale. (The full listing of questions appears in Tables 3 and 4, below).

Transfer of training following the videodisc experience. A final concern of the this study was what effect, if any, the experience of using the videodisc would have on the instructional practices of the seven participating teachers when returning to conventional curriculum materials. To gauge the effect of the program, teachers were observed teaching the target class three times prior to the

intervention and then three times, two weeks following their use of the Mastering Fractions program.

During the observed lessons, teachers used conventional print curricula, occasionally teacher-developed dittos. The observational scale utilized selected variables from the research on effective mathematics instruction to low-achieving students (Good, Grouws & Ebmeir, 1983). The list of observed variables is found in Table 4 below. This observational system was developed nine months prior to the beginning of the study.

Impact of the program on students: Achievement and reactions. Students were tested prior and after 30 days of implementation on a curriculum-referenced test that covered all major topics in the curriculum--the meaning of fractions, equivalence of fractions, and computations involving fractions with like and unlike denominators. The coefficient alpha reliability of this test is .98 (Kelly, Gersten & Carnine, in press).

In addition, a research assistant interviewed the students during the final week of implementation. This brief 5-10 minute interview consisted of seven questions. The interviewer asked students to describe their impressions of the program and the experience of learning with the interactive videodisc medium.

## Results

### Teachers' Implementation of the Innovation: Observational Rating Scale Findings.

Table 1 shows observed level of videodisc implementation by the end of the fourth week of the study. Results on the first four items were yes/no. Items 5 through 9 were completed on a 3-point scale where 1 was never, 2 sometimes, and 3 always.

After 4 weeks of use, teachers were implementing most major components of the program at an acceptable level. They appeared familiar and comfortable with the remote control device and the basic operation of the videodisc player. All teachers were utilized the Checks for Student Practice (i.e. guided practice) component daily. Students were seated so that they could see the screen. There was only one area where teachers demonstrated problems: two teachers did spend part of each period with other math activities (such as math fact games) and/or spent time in non-academic activities.

[Insert Table 1 here]

The lower half of Table 1 shows the results of rating scale items. These address the more subtle and sophisticated instructional techniques. The teachers provided the remediation activities specified in the program at the designated points most of the time (mean of 2.68 on a 3-point scale). They virtually always gave students time to check their work when the answers to problem sets were presented on the screen, and, as instructed, they spent a considerable amount of time circulating around the room to monitor independent student work.

The videodisc procedures for guided practice, careful monitoring of students' independent work, and provision of brief remedial "mini-lessons" whenever students experience difficulty all appear to be implemented at an extremely high level. Overall, the observation data indicate that teachers tended to exhibit the research-based effective teaching techniques that were intended by the program developers.

Direct observational measures. One concern before the study was the extent to which teachers would provide explanations of fraction concepts in their own words, a practice which might contradict the consistent wording utilized in the videodisc curriculum and, thus, confuse the students. Expert judgment was used to determine the consistency of the teacher explanations to that of the program, and the mean number of consistent explanations for any given period was 8.7, whereas the mean number of inconsistent explanations was 3.4. This ratio of consistency to inconsistency is approximately two and one-half to one. While the mean number of inconsistent explanations is potentially troublesome, it is still surprising how much more often the teachers explained fractions concepts in the same way as the program, especially considering the fact that all of them had been teaching fractions in a more traditional manner for many years.

Finally, evidence from the classroom observations showed that the videodisc program was used in a non-critical atmosphere. Average number of teacher criticisms to students (e.g., insults, expressions of disgust or anger, harsh feedback) was approximately one per period.

Teachers' Perceptions of the Videodisc Experience: Findings from Semi-structured Interviews.

Table 2 presents the results for the questions with fairly clear-cut yes/no responses. Table 3 uses a key word method to summarize results on the more open-ended questions.

[Insert Table 2 here]

Technical and logistical issues. All seven teachers found the interactive videodisc easy to use. Considering the complexity of the most educational technologies, and the fact that only one of the teachers had previous experience utilizing any type of educational technology up to this point, this is an unusual finding. In one teachers' words, it was only a bit more difficult to use than a home VCR.

Teachers did experience some implementation problems, however. One of the seven had problems with the remote control (item 2). A few teachers were initially confused with the logistics of using the decision menus for remediation and review. They indicated that these problems diminished with practice. By the end of the study, all felt comfortable with the procedure.

Utility of remediation activities and guided practice (checks for student progress). All teachers but one thought the extensive use of remediation and guided practice incorporated into the program helped students really master the material. One of the seven felt the extensive use of remediation and guided practice did slow down overall class progress slightly, however. This is a constant dilemma for those employing any type of instructional model combining mastery learning and group instruction.

Three of the seven teachers needed to frequently play back lesson segments for review and remediation purposes. For the other four, the pace of the curriculum was such that remediation activities were rarely needed. Thus, though the majority of the teachers like the concept of guided practice checks every five minutes or so, not all the teachers had an opportunity to really try them out. The observers also reported (Table 1) that teachers were implementing the guided practice and remediation segments properly.

Perceptions of the overall utility of the videodisc curriculum. All seven special education teachers felt the students were mastering the skills. As mentioned

earlier, these teachers had previously found fractions one of the most difficult topics in mathematics to teach, and were dissatisfied with most existing curricula. All but one of the teachers felt that students participated more in the lesson with the videodisc than with conventional instruction. In years past, many students had failed to learn several of the major topics covered. During the open-ended segment of the interviews, teachers indicated the specific strategies that they found to be successful -- the use of a number line, the instructional strategy for finding least common denominator, and the teaching of improper fractions. Finally, teachers were asked to provide a global rating of the videodisc curriculum on a 1 to 5 scale. The mean score was 4.5, an above average assessment for an innovative practice.

Results on open-ended items. Table 3 presents a brief summary of how teachers responded to the open-ended questions. They unanimously found the graphics and special effects to be the best features of the curriculum. They all mentioned how the computer graphics could visually demonstrate relationships and concepts so much more elegantly, with so many more examples, and so much more quickly than they could with a chalkboard or colored paper and scissors. They also expressed that the students seemed much more interested and attentive to the bright colors, and visual excitement of the graphic displays.

[Insert Table 3 here]

However, over half the teachers also were sensitive to the design of the curriculum. They talked about the orchestration of skills across many lessons, the range of activities incorporated into each lesson, and how this curriculum was designed so differently than conventional texts, which tend to focus on only one topic per lesson with minimal review. They pointed out how the constant review was essential for low-achieving students, and how the variety of activities with a lesson helped keep the students interested.

The teachers generally felt this type of subtle orchestration of skills would be extremely difficult, if not impossible, without the aid of technology. Finally, two of the seven teachers mentioned the provision for remediation as one of the best features of the curriculum.

One factor emerged as a weak feature of the program. Three of the seven felt there was too much paperwork involved in the rather complex mastery learning system that involved daily checks of independent seatwork, as well as group checks of daily quiz performance.

We next asked teachers to indicate how teaching with the interactive videodisc curriculum was different from their conventional curriculum. The majority of the teachers pinpointed that things were broken into much smaller steps than is typical. The teachers cited the advantage of such an approach for teaching low performing students.

Several of the teachers also felt that with this curriculum, they were able to monitor student work more frequently and more precisely than before. They talked about how their role had shifted a from an individual who primarily explains and demonstrates new concepts to one who primarily makes sure students understand the new material, and helps those students with problems. All seven teachers thought the interactive videodisc had great potential for future use in both special education and regular classroom instruction, particularly in the areas of mathematics and science.

The videodisc curriculum is much more directive about teacher behavior than conventional instruction; and the role of the teacher much more precisely defined and delimited. We inquired how teachers felt about this. All seven teachers liked the way everything was structured and laid out for them. They all felt that as a result of the videodisc, they did "less talking" and explaining. As one teacher put it, "To be honest, I used to get only 15 minutes of instruction out of a regular period [45 minutes]. With this program, I get 45 minutes of teaching."

When some individuals first see the videodisc, they think that teachers won't like it, that, essentially, it replaces the teacher. So we were curious to see how these teachers felt after six weeks of implementation. We asked whether they felt "replaced" by the videodisc. All but one said no. They saw their role as providers of feedback and support as essential. They also saw the importance of what several called "the human factor," the need for an adult to make instructional decisions.

Transfer of Training Following the Videodisc Program

Observers documented teacher performance across of variety of effective teaching behaviors. Table 4 shows performance on these behaviors before and after the intervention.

[Insert Table 4 here]

Perhaps the most evident and important effect of the program was the change in the number of problems modeled by the teacher prior to assigning independent work, and the number of guided practice problems. The videodisc curriculum stressed the use of a) presentation of numerous models of each problem type , and b) the use of guided practice before asking students to work on their own. Teachers incorporated this approach into their day-to-day teaching.

A correlated t-test showed significant increases in the modelling of strategies ($t = 2.13$, $df = 6$) and use of guided practice ($t = 4.27$, $df = 6$). This growth corresponded with a dramatic improvement in student accuracy on independent work, from a mean of 68.75% prior to implementation to a mean of 83.04% subsequent to use of the videodisc ($t = 3.03$). One of the primary features of the videodisc program is insuring a high student success rate through step-by-step instruction. The fact that this carried over to conventional instruction is a very positive sign.

There appeared to be little change in the number or type of questions asked, with one exception. Teachers asked significantly fewer logistical/non-instructional questions ($t = 3.46$, $df = 6$). Teachers continued to conduct their classrooms in a cordial manner, with a relatively high ratio of praise to criticisms (approximately four to one).

Effects of the Videodisc Program in Student Achievement

A criterion reference test developed by the program writers was used as a pre- and posttest measure of achievement. Table 5 shows the mean pretest, posttest, and gain scores for the students with fewer than five absences during the course of the study. As can be seen from the table, the mean pretest performance was quite low, 29.4, and standard deviation of 9.38. The mean posttest was considerably higher (mean = 79.0, SD = 10.08). This resulted in an overall mean gain score of 49.7 (SD = 8.81).

Using a score of 80 percent on the posttest as an acceptable level of performance, almost two thirds of the students (64 percent) reached or exceeded criterion performance on the posttest. These data reveal consistent marked improvement across the seven secondary special education classrooms. The mean level of performance is somewhat less than what was found in the previous, more controlled experimental study of the fractions curriculum (i.e., Kelly et al., 1986), where the mean was 95 percent. However, the current findings are at a reasonable

performance level, especially considering that these were all special education students.

Observational data indicate that students were engaged in academic activities at a reasonable rate -- with an on-task rate of 78% (SD = 4.4). This was only a modest increase from the engagement rate observed prior to instruction of 75.5%. However, observational notes indicated that there were times when several students in the group would be waiting for others to finish up their guided practice exercises.

Student seatwork was collected after each observation. Students tended to be quite successful in their independent work. On the average, student success rate for independent seatwork was 82% (SD = 7.37).

[Insert Table 5 here]

Student Interviews

Table 6 presents the main questions and open-ended responses from an individually conducted, ten-minute interview. Students were consistently positive about the program, not only in their general reactions to the curriculum, but as a way to learn math. Almost 90 percent of the students felt more self-assured in the ability to work fraction problems and almost the same percent would like to continue to learn fractions in this way. Researchers were particularly concerned with how students would feel about answering aloud. Less than one third of the students had a negative reaction to answering aloud, whereas over half had a neutral reaction. This kind of reaction corresponds to the observational data which revealed that teachers typically only had students answer aloud some of the time. It is difficult to say at this point how important this practice is at the secondary level.

[Insert Table 6 here]

One final concern was the amount of step-by-step instruction in the program built into the program. There is a considerable amount of cumulative review and additional practice problems for students who fall below criterion on unit tests or guided practice problems. Approximately one-sixth of the students thought that there was too much repetition, while almost half thought it was acceptable the way it was. The only other common concern was the amount of writing, not only the copying of problems from the screen, but the worksheets and tests that accompanied the program.

## Discussion

The unexpectedly positive reaction to the videodisc program can be traced to several sources. First, as an innovation, it met explicit teacher needs. It provided a better, more effective way to teach fractions to secondary learning disabled students. All teachers felt that the new curriculum was more effective than anything they had used previously, and that most of their students were actually understanding the concepts.

The National Assessment of Educational Progress (NCTM, 1988) has consistently shown that many secondary students never learn fractions. For most of the students in the study, this was the third time they had been taught a unit on fractions. The fact that the majority were finally succeeding in learning these difficult concepts was a major refrain of teachers' interviews. Fractions instruction had been a difficult instructional area for these teachers for many years. As the research of Guskey (1984) and Berman and McLaughlin (1976) has found, teachers' attitudes towards new instructional practices are largely shaped by how well the new program succeeds with their students, especially difficult-to-teach students such as those in the current study.

Overall, the one effect of the videodisc implementation was a transfer of teaching skills to conventional practices. After using the program, teachers tended to model more problems and provide more guided practice. Their teaching styles tended to become more interactive. Some in the area of school change argue that this should be a main goal of training in a new strategy or instructional technique (Showers, Joyce, & Bennett, 1987).

In this study, teachers' enthusiasm was appreciably higher, and more consistent, than that found by the earlier research on research-based practices such as mastery learning (Duckworth & Fielding, 1985; Guskey, 1984) and direct instruction (Gersten, Carnine, Zoref & Cronin, 1986). Several factors might help explain this.

First, teachers were being asked to use the videodisc for just one subject area and for only one or two periods a day. The relatively small scope of the intervention reduced stress and enhanced the likelihood of initial success (Fullan, 1982; Huberman & Miles, 1984). Furthermore, a modest amount of knowledgeable, follow-up technical assistance was available. This seemed to make a considerable difference in the level of implementation (Cox, 1987; Huberman & Miles, 1984; Loucks & Zacchei, 1983; Showers, Joyce, & Bennett, 1987). Repeatedly the participating teachers commented on how they enjoyed the fact that a facilitator was

available to answer questions, to give them a sense of how they were using the program, and to clarify why the program was designed the way it was.

In addition, it is evident from this observational data and teacher interviews conducted after the study that all teachers found the videodisc technology easy to use. After one or two days of some minor confusions (e.g., how to use particular remote control buttons, how to read decision menus), teachers felt comfortable with the remote control device and the basic operation of the program.

Finally, several of the teachers indicated how the videodisc freed them up to perform other teaching functions with more precision. They were now able to monitor carefully how all students were doing, provide praise and encouragement to students for effort, or provide brief, focused tutorial sessions. The structure of the videodisc allowed them to teach in a more interactive fashion, to more closely follow the model of teaching that research has found to be effective, particularly for low achieving students (Brophy & Good, 1986).

Relationship to Executive Functions of Teaching

The main reason for the lack of serious implementation problems may be the fact that the interactive videodisc curriculum was designed to be consonant with conventional classroom organization and structure. In their review of the research on educational innovation, Loucks and Zacchei (1983) concluded that educational innovations are much more likely to succeed if they do not conflict radically with traditional organization of classrooms and the instructional strategies teachers employ. The videodisc lessons fit traditional ideas of what a class routine is like and what teaching is like.

Teachers still taught the entire group, and still were able to perform typical teaching functions -- monitoring seatwork, checking for understanding, motivating students, and providing individual tutorials to students who were experiencing difficulties. Whereas many other technological innovations call for radical restructuring of the teachers' role and the mode of instructional delivery, the videodisc curriculum merely accentuates or improves upon the existing method of teaching. In a sense, videodisc technology is more consistent with the culture of the classroom that Cuban (1986) describes than, for example, the banks of microcomputers in a typical computer lab. The role of a teacher and the nature of his or her relationships to students is radically different in a computer lab than in a conventional classroom.

While the role the teacher played in this study was within the bounds of typical classroom instruction, there were appreciable shifts. Teachers focused almost exclusively on monitoring student progress, providing support and providing remediation. The videodisc software did all the initial demonstrations of new concepts, presented the practice examples, showed students how to solve problems, how to estimate, and how to check their work. Interestingly, teachers did not seem to resent this shifts.

During the interviews, teachers were asked to reflect of how this approach compared to conventional practices. On several occasions they referred to the efficient and effective management of time and the way the curriculum broke instruction into discrete, well-sequenced steps. Many teachers described how they would incorporate segments of the program -- especially the use of a number line -- into the way they would teach fractions again. In fact, the observational data revealed that, at the conclusion of the study, teachers did incorporate some of the videodisc's practices into their conventional teaching.

Much of this points to issues raised by Berliner (1985) in his essay on executive functions of teaching. Day-to-day instruction is a very complicated and all-consuming activity. Rarely do teachers have the time or resources to do one aspect of teaching well -- be it classroom management, individual tutoring, modeling new concepts to the class as a whole, or giving corrective feedback. To the extent that technology based programs such as the one used in this study can relieve teachers of their many obligations and, at the same time, provide expertise in one area, the quality classroom instruction can be dramatically affected.

In no way does this imply that videodisc instruction should be used in all subject areas, as a constant companion throughout the day. It is <u>not</u> the hidden remedy to a flagging computer revolution in the schools. Rather, as a modest innovation that blends the power of a particular technology, especially its graphic capabilities, with carefully designed instruction, it is a partial solution to the problem of effectively teaching a difficult subject area like fractions. It can not only free the teacher to perform other executive functions better than before, but it can provide high quality instruction in the mode of curriculum presentation. Rather than pitting instructional technology against traditional practices, it is more constructive to think of technologies contribution in the framework of Berliner's executive functions.

Table 1

Videodisc Observation Items [a]

| Issue | Percent of Teachers Responding Affirmatively |
|---|---|
| 1. Teacher demonstrates familiarity with the disk player and its operations | 92.2 |
| 2. Students seated so that the screen is clearly visible | 100.0 |
| 3. The teacher used the program the entire period (at least 45 minutes) | 66.6[b] |
| 4. Teacher uses the Check for Student Progress (guided practice) aspect of the lesson at designated times | 100.0 |

| Issue | Mean Rating on a 1 - 3 Point Scale | SD |
|---|---|---|
| 5. The teacher provides specific remediation activities at designated points in the videodisc lesson | 2.66 | .52 |
| 6. The teacher gives students sufficient time to work and check their answers | 2.83 | .19 |
| 7. The teacher proceeds through the lesson at a brisk pace | 2.58 | .49 |
| 8. The students respond as a group to the narrator's questions | 2.00 | .35 |
| 9. The teacher circulates around the room monitoring students | 2.86 | .24 |

[a] N = 7 teachers, 2 observations per teacher

[b] Not applicable for 2 observations

Table 2

Teachers' Perceptions of Use of Interactive Videodisc to Teach Fractions

| | Percent of Teachers Who Answered Yes: |
|---|---|
| **A. Technical Issues** | |
| 1. Do you find the videodisc itself hard to use? | 0% |
| 2. Do you have problems using the remote control? | 14% |
| 3. Do you get confused making the right choices at the decision menus when they ask if 1/5 of the students missed the problems)? | 14% |
| 4. How about remediation after quizzes? | 43% |
| **B. Utility of Remediation and Guided Practice in the Videodisc** | |
| 5. Do you think it helps students master the material? | 86% |
| 6. Does it end up slowing down progress? | 14% |
| 7. Do you use these frequently to play back chapters that the students need additional practice on? | 43% |
| **C. Overall Perceptions** | |
| 8. Do they participate more that they did in your regular curriculum? | 86% |
| 9. Do the students seem to be mastering the skills? | 100% |
| 10. How would you rate your experience with the program overall on a scale of 1 to 5, with 5 being the highest and 1 being the lowest? | 4.5 |

Table 3

Open Ended Questions

Percent of Teachers Who Used the Following to Answer Each Question:[a]

1. What are the best features of the program?

| | |
|---|---|
| A. Graphics as a means of demonstrating concepts | 100% |
| B. Special effects | 86% |
| C. Design of the curriculum/ orchestration of skills and activities | 57% |
| D. Remediation | 29% |

2. What are its weakest features?

| | |
|---|---|
| A. Too juvenile or oriented to young students | 14% |
| B. Too much paperwork | 43% |

3. What are the biggest ways that it is different from how you taught fractions before?

| | |
|---|---|
| A. Things are broken into smaller steps | 71% |
| B. More monitoring of student work than before | 43% |

4. What changes have you seen in the students?

| | |
|---|---|
| Improved work habits | 86% |

5. What kind of future do you think something like the videodisc has in the schools ?

| | |
|---|---|
| Great | 100% |

6. Do you like the way everything is laid out for you, the way everything is structured? 100%

7. Some people have reacted to this kind of use of the videodisc by saying that it will "replace" the teacher. What do you think about this kind of reactions?

| | |
|---|---|
| A. It won't replace the teacher | 86% |
| B. You always need a human factor, someone to make decisions | 43% |

[a] A "key word" approach was used to classify responses

Table 4

Transfer of Teaching Skills: Results of Classroom Observations

| Issue | Prior to Videodisc | | After Videodisc | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| 1. Number of Problems Modeled* | .43 | .93 | 2.43 | 2.17 |
| 2. Number of Guided Practice Problems** | 3.14 | 2.87 | 9.79 | 4.40 |
| 3. Number of Product Questions | 13.67 | 7.38 | 12.32 | 4.13 |
| 4. Number of Process Questions[a] | 2.83 | 2.08 | 1.65 | .36 |
| 5. Number of Logistical or Non-Academic Questions** | 4.73 | 1.18 | 2.02 | 1.80 |
| 6. Number of Probing Questions During Corrections | 9.14 | 5.50 | 10.21 | 4.59 |
| 7. Amount of Praising | 14.96 | 6.31 | 14.84 | 5.52 |
| 8. Amount of Criticisms | 1.64 | 1.92 | 2.01 | 1.08 |
| 9. Success Rate on Independent Work** | 68.75 | 11.45 | 83.04 | 5.56 |

* $p < .05$
** $p < .01$
[a] $p < .15$

Table 5

Mean Videodisc Achievement Results

| Teacher | N | Mean Pretest | SD | Mean Posttest | SD | Gain |
|---|---|---|---|---|---|---|
| 1 | 7 | 35 | 21.2 | 68 | 18.2 | 33 |
| 2 | 6 | 43 | 21.9 | 87 | 8.8 | 44 |
| 3 | 7 | 15 | 20.7 | 64 | 19.9 | 49 |
| 4 | 6 | 33 | 18.6 | 85 | 11.8 | 52 |
| 5 | 7 | 29 | 10.3 | 84 | 7.3 | 55 |
| 6 | 7 | 20 | 14.8 | 75 | 14.1 | 55 |
| 7 | 6 | 31 | 18.3 | 90 | 7.1 | 59 |
| Total | 57 | 29.4 | 9.4 | 79.0 | 10.1 | 49.6 |

Table 6

Student Interview Data

(N= 57)

1. In general, what was your reaction to the videodisc math program?

| | |
|---|---|
| Negative to Neutral | 14.1% |
| OK to Good | 78.9% |
| Loved It | 3.5% |

2. Do you think that it is a good way to teach math?

| | |
|---|---|
| Yes | 96.5% |
| No | 3.5% |

3. What did you like best about the videodisc program?

| | |
|---|---|
| The graphics and use of a TV | 38.5% |
| The way the teacher taught | 19.3% |
| It wasn't boring | 12.3% |

4. What didn't you like about the program?

| | |
|---|---|
| It was OK the way it was | 47.7% |
| Too much writing | 14.0% |
| Too much repetition | 14.0% |

5. How did you feel about answering aloud so often?

| | |
|---|---|
| Negative | 29.8% |
| Neutral to OK | 52.7% |
| Good | 17.5% |

6. Do you think that you know how to do fractions now?

| | |
|---|---|
| Yes | 89.4% |
| No | 5.3% |
| Not sure | 5.3% |

7. Would you like to continue to learn fractions this way?

| | |
|---|---|
| Yes | 87.7% |
| No | 12.3% |

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